

Intense Energy, Vorticity, and Strain Focusing in Nonlinear Fluid Flows

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PECASE DMR-9896037
DMR-0244581

We have explored focusing of energy into jets in extreme surface waves (Nature 403, 401: Jan. 27, 2000), and the focusing of strain and rotating motions in turbulent flows with violent vortices (Nature 421, 146: Jan. 9, 2003).

The image to the right shows a multiple exposure of a collapsing surface wave and its resulting upward jet. These experiments show the unusual nature of surface wave dynamics which can lead to important effects in engineering flows and ocean surfaces. This research addresses how energy can be gathered into a small portion of a moving fluid by self-focusing.



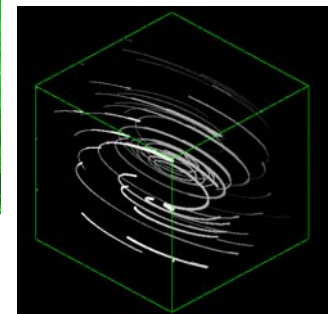
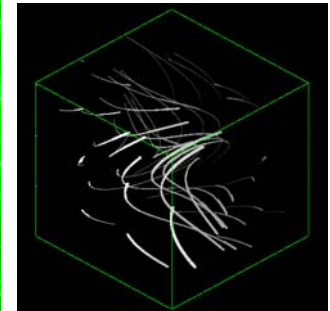
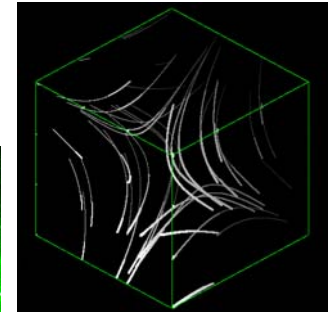
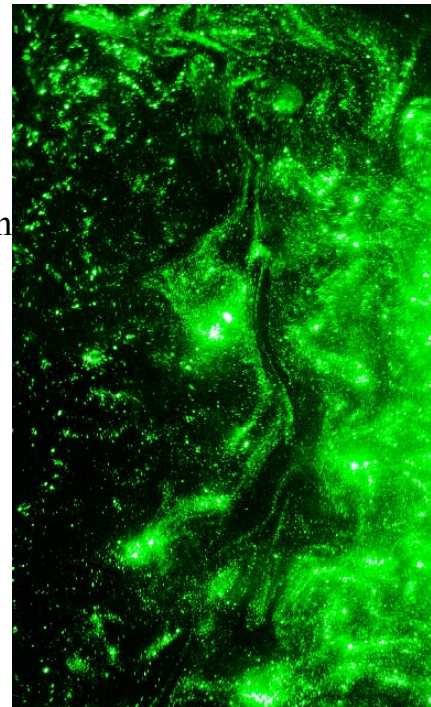
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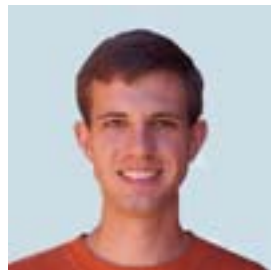
Turbulent flows exhibit intense bursts of vorticity and strain. Turbulent intermittency can be important, for example, for enhancing the mixing of chemicals, by producing sharp drops in local pressure that can induce cavitation (damaging mechanical components and biological organisms), and causing intense vortices in atmospheric flows. Our research has examined the cause of local intense strains and rotational motions in turbulent flows using new optical laser diagnostics. These studies are important for modeling and predicting turbulent flows.

Education/Outreach:

The mentoring of students is an important part of this research. Seven Ph.D. students and seven undergraduates were involved. Outreach includes public talks and tours for the Maryland MRSEC middle school girls program.



Ben Zeff
Ph.D. student



Dan Lanterman
Ph.D. student



Woodrow Shew
Ph.D. student



Barbara Brawn
Undergraduate



Dan Blum
Undergraduate